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ABSTRACT

Computer usage by preschool children differing in cognitive tempo was explored. Cognitive tempo refers to a child's tendency to respond slowly or rapidly in a problem-solving situation which has high uncertainty. The Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP) was administered to 13 children enrolled in a prekindergarten class at a day care center. Of the sample, three children were identified as reflective (responding slowly) and three as impulsive (responding rapidly). Data were collected via a computerized observational checklist developed by the researcher. It was found that children classified as impulsive made more errors when using the computer than did children classified as reflective. When subjects were rank-ordered according to error scores received on the KRISP and the computerized checklist, order was preserved except for two subjects. Little difference was observed in the frequency and length of computer sessions by impulsives and reflectives when compared as groups; however, much variation between individual subjects was evident. Use of the computer as an observational tool was found to have several advantages, including reduced observer bias and greater accuracy in recording observations. (Author/RH)

Effect of Cognitive Tempo on Preschool Children's Use of the Computer

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Effect of Cognitive Tempo on Preschool Children's Use of the Computer

Abstract

This study looked at the differences in computer usage by preschoolers with differing types of cognitive tempo. The Kansas Reflection - Impulsivity Scale for Preschoolers (KRISP) was administered to thirteen children enrolled in pre-kindergarten class at a daycare center. Of this sample, three children were identified as reflective and three as impulsive. Data were collected via computerized observational checklist developed by the researcher. It was found that children classified as impulsives made more errors when using the computer than did children classified as reflective. When subjects were rank ordered according to error scores received on the KRISP and the computerized checklist, order was preserved except for two subjects. Little difference was observed in the frequency and length of computer sessions by impulsives and reflectives when compared as groups; however, there was much variation between individual subjects. The use of the computer as an observational tool was found to have several advantages, including reduced observer bias and greater accuracy in recording observations.

Key Words: Cognitive tempo, computer, preschool.

For good or for ill, computers have become a fixture in today's classroom and, if the current trend continues, will have an even more integral role in the learning process in the future. Surveys conducted by Johns Hopkins University showed that, as of January 1983, 53% of all schools in the United States had obtained at least one microcomputer for instructing students, with 42% of the nation's elementary schools and 85% of the secondary schools having computers (Becker, 1983). At a 1984 conference sponsored by the National Institute of Education, it was predicted that home instruction would soon be used as a supplement to traditional school instruction, with home computers routinely used for homework, independent learning, and the development of computer proficiency (Holden, 1984).

Advocates of this new technology point out the benefits of being able to individualize instruction with computers, allowing teachers to develop instructional materials which meet the individual needs of students at their own developmental levels. Source: (Bork, 1981, 1984; Bower, 1984; Flake, et al, 1985; Samways, 1981.) More research is needed, however, to determine what factors affect how children learn and how such factors affect children's interaction with computers.

Cognitive tempo has been identified as one factor affecting the learning process (Kagan, 1965). Cognitive tempo refers to a child's consistent tendency to respond slowly or rapidly in a problem-solving situation which has high uncertainty, that is, when several alternatives exist simultaneously and the correct choice is not readily apparent. In such situations, those children classified as reflective tend to have long response times (latency) and make few errors, while impulsive children typically respond quickly and make many errors (Kagan, 1965).

Research has characterized preschoolers most interested in using computers as being cognitively more mature, and as exhibiting significantly higher levels of representational competence and abstract forms of free play behavior (Clements, 1985a). Children classified as having a reflective cognitive tempo have also been described as having greater cognitive maturity and analytic problem-solving ability, and as exhibiting more representational play (source: Bush & Duck, 1975; Kagan 1966). Research has linked cognitive tempo with various learning tasks including flexibility of cognitive style (Bush & Dweck, 1975), transfer of learning (Odom, et al., 1971), and flexibility in problem-solving styles (Zelnicker & Jeffery, 1976).

Purpose

The primary purpose of this study was to determine whether a young child's cognitive tempo would affect his use of a classroom microcomputer. Microcomputers are being widely used in early childhood and primary classes, yet little research has been done to determine what affect a child's individual learning style will have on his use of this tool.

A secondary purpose of this study was to develop a computerized observational checklist which would record data as the children used the software. Recorded data included the subject's name, date of session, length of session, total number of responses, and total number of errors per session.

Objectives of the Study

The objectives of this research were to examine the following areas with respect to the stated problem:

1. To determine whether impulsive children made more errors when using the microcomputer than reflective children.
2. To determine whether impulsive children used the computer less frequently than did reflective children.

3. To determine whether impulsive children used the computer for shorter periods of time than did reflective children.

Method

Subjects

Subjects were those preschoolers, aged 4 years 6 months to 5 years 10 months, enrolled in the prekindergarten class of a daycare program in Stillwater, Oklahoma. Two girls and 11 boys were enrolled in the program. The daycare program is part of a non-profit corporation and is funded with public monies and fees paid by parents. Subjects were not randomly chosen, but belonged to an intact group. All children were allowed equal access to the computer; however, only data for those children classified as impulsive (N=3) or reflective (N=3) were considered for this study.

Instruments

The Kansas Reflection-Impulsivity Scale for Preschoolers (KRISP), Form A, was used to classify subjects as reflective, impulsive, efficient, or inefficient. The test is a match-to-standard-task in which a subject is to identify the one figure among four to six variants which exactly matches the presented standard. The standard and the variants are presented simultaneously and are always available to the subject.

According to Wright (1978) test-retest reliability for the KRISP is reported as .581 for latencies (time taken to respond) and .746 for errors. Equivalent forms reliability is reported as .718 for latencies and .587 for errors. Concurrent validity was established by correlating scores from the KRISP and the Matching Familiar Figured Test (MFF). Wright (1978) reported a moderately significant correlation between the scores, given the limited test-retest reliability of the KRISP and the MFF.

Since cognitive tempo has been correlated with cognitive ability, the Peabody Picture Vocabulary Test Revised (PPVT-R), Form M, was administered to determine the subject's approximate cognitive level. Internal consistency for the PPVT-R (form M) is reported as .61 to .86, and test-retest reliability is reported as .78 (McCallum, & Wiig, 1984). Previous experience with computers might also affect how receptive children were to using a computer, so parents were asked to complete a questionnaire regarding their child's previous experience with computers. Previous experience included the child's own use of a computer and observation of others using computers.

To collect data for this study, a checklist was developed by the researcher to record the number of times each subject used the computer, length of each session, total number of keystrokes per session, and number of errors (invalid keystrokes) per session. This checklist was incorporated into the software program, enabling the computer to record the pertinent data.

Data Collection

Data were collected using an IBM PCjr. This microcomputer consists of a color monitor, keyboard, system unit, and one floppy disk drive.

The software provided for the children's use was an original program developed for this project. Software was written in the Pascal assembly languages and employed turtle graphics. The program was initiated by typing in the current data and time and the child's name. The subject was then able to use the screen turtle to draw designs or pictures as desired. Seven keys were functional: F (moved the turtle forward 1 space), B (moved the turtle backward 1 space), R (turned the turtle 15 degrees to the right), L (turned the turtle 15 degrees to the left), E (erased the previous one-space movement without changing the directional orientation of the turtle), C (changed the color in which the turtle drew), and W (cleared the screen of all previous drawing).

These keys were marked with color-coded dots: blue for movement keys (F, B), red for directional keys (R, L), and yellow for function keys (E, C, W). All other keys were unmarked and, if pressed, had no effect on the visual display.

This software also recorded observational data. Use of any marked key was recorded as a correct keystroke. Use of any unmarked key was recorded as an incorrect keystroke.

Procedure

Step 1. Administering the KRISP.

The Kansas Reflection-Impulsivity Test for Preschoolers (KRISP) was administered to all children enrolled in the prekindergarten class. Children were tested individually in an area separate from the classroom.

Step 2. Introducing the computer.

An IBM PCjr was set up as an additional interest center in the prekindergarten classroom of an Oklahoma daycare center. The children were introduced to the parts of a computer during a group activity period. A poster illustration was used to explain the color-coding system of the computer keyboard. The children were instructed that only color-coded keys would work when using the computer. The color-coded poster was available at all times while the children used the computer, and the researcher was also present at all times to answer questions.

Step 3. Using the Computer

Children in the program were allowed access to the computer during the morning self-select play time (approximately 9:30 to 11:00 a.m.) on Monday through Thursday for a period of three weeks. This time period was chosen based on observations made by another researcher. Rutledge (1986) found that children maintained interest in a particular software package for approximately three weeks. Due to the prohibitive cost of software, only one software package was available for use during this study. Children signed a waiting list to use the computer, and were allowed to sign up for more than one turn per day if they wished. Other classroom activities were available to the children while they waited for their turn to use the computer.

Step 4. Final Data Collection.

At the conclusion of the computer session, parents were asked to complete a survey regarding their children's previous computer experience, and the PPVT-R was administered to all subjects. The time period for testing was extended to three weeks, due to several schedule conflicts with subjects' family vacations.

Results

All subjects (N=13) were administered the KRISP to determine cognitive tempo. An identifying number was assigned to each subject for the purpose of reporting data. Using a double-mean split for latencies and errors, three children were classified as impulsive, five were classified reflective, four were efficient, and one was inefficient. Of the original thirteen children, two children classified as reflective and one child classified as impulsive dropped out of the program prior to the completion of the study. This study does not include data for children classified as efficient or inefficient, or for those who dropped out of the program.

The six subjects considered in this study were all males. (See table 1) The subjects' ages were within a range of 13 months, with both the oldest and the youngest subject classified as reflective. The PPVT-R was administered to establish an approximate cognitive level for each subject. PPVT-R scores were higher for reflective subjects than for impulsive subjects by one to two and one-half years. None of the subjects had any significant computer experience, with only one child having used the computer infrequently prior to this study.

Insert Table 1 About Here

For the purpose of this study, a graphics software package was developed which utilized only seven computer keys. These keys were color-coded and their function explained and demonstrated to all subjects. As the subjects interacted with the software, a separate part of the program (the checklist) recorded the length of the session and the number of correct and incorrect keystrokes. The use of any unmarked key was counted as an incorrect keystroke.

Mean errors per minute and mean errors per 100 keystrokes were calculated for each subject (see table 2). It was noted that impulsive subjects made more errors than reflectives when considering both errors per minute and errors per 100 strokes. When subjects were rank ordered according to error scores on the KRISP and the computerized checklist, order was preserved with the exception of the two subjects occupying positions three and four.

Insert Table 2 About Here

The number of computer sessions and mean length of the sessions were also observed for each child. Little difference existed for frequency of computer use for impulsive ($X=3.33$) vs. reflective ($X=3.00$) children. Session length was an average of 15 percent longer for impulsive (X length of sessions = 17 minutes, 14 seconds) than for reflectives (X length of sessions = 14 minutes, 46 seconds).

Discussion and Summary

The age range for the subjects was 13 months, with both the oldest and youngest child being classified as reflective. The PPVT-R Mental Age Equivalent scores for reflective subjects were higher than those for impulsive subjects by one to two and one-half years. This seems to indicate a higher cognitive level among the reflective subjects, a finding consistent with that of other researchers (Block et al., 1974, Bush & Dweck, 1986). This factor may have had some effect on the number of errors made by the subjects. Errors were counted as the use of non-functional keys, meaning that subjects had to remember which keys would change the graphics display and which would have no effect. It was noted by the researcher that impulsive subjects asked for help in deciding which keys to use more often than did reflective, even though the functional keys were color-coded and their functions described pictorially on a nearby poster. Previous experience did not appear to be a factor in how subjects used the computer since only two children had minimal exposure to computers prior to this study.

An interesting relationship between computer errors and KRISP errors was noted. When rank ordered according to error scores on the KRISP and the computerized checklist, order was preserved except that the two subjects occupying positions three and four switched places; that is, subject 1 made more errors on the KRISP than Subject 9, while Subject 9 made more computer errors.

In future studies, it may prove useful to modify the software to calculate latencies for keystrokes as well as total errors. In this way, a comparison for both latencies and errors between KRISP scores and use of the computer could be made. If rank ordering for both latency and error scores were consistent, it may be possible to measure children's cognitive tempo using a computer program similar to the one employed in this study.

Software for the present study did calculate mean latency and standard deviation of latency for each session; however, the general shape of the latency distribution curve is not known, thus this data is of minimal use. This problem could be remedied through a software modification which would create a frequency histogram for response latencies within specified ranges.

In comparing computer use by impulsive children and reflective children as groups, there appeared to be very little difference in the frequency of use among the few children involved in this case study. There was, however, much variation in the number of times individual subjects used the computer, with one reflective and two impulsive subjects using the computer at least twice as frequently as the other three subjects. As a group the impulsive subjects' sessions were longer than the reflective subjects sessions by 15%. Once again, however, there was greater variation among individual subjects, with one impulsive and one reflective child having the greatest mean length of sessions. Because of the small sample size, it is difficult to make comparisons between groups; however, the results indicate that, while impulsive children did make more errors than reflective children, this did not diminish their use of the computer.

Several factors may have influenced both the frequency and length of computer sessions. This study was conducted during the summer months, and several subjects were absent frequently due to family vacations and other activities. This limited the number of times the children were able to use the computer. Also, all of the children in the program were allowed equal access to the computer, not just those for whom data is included in this report. Fewer than half of the computer sessions recorded by the software were sessions of reflective and impulsive subjects. Computer access for the children was limited due to the fact that only one machine was available for their use.

The software itself may also have been a limiting factor in how frequently the computer was used. The researcher observed that the reflective children tended to learn how to operate the software more quickly than the impulsives. They also explored the software's functions more quickly and then lost interest in it. A more complex software package employing a greater variety of functions may have been more interest sustaining for the reflective subjects.

The current study employed an interactive graphics program for which there was essentially no negative feedback. However, many of the most popular educational programs do employ such feedback. It may be that utilizing a more structured program which provides positive and negative feedback would affect the frequency and length of computer sessions.

Several advantages to using the computer as an observational tool were noted. One of the problems faced by researchers conducting observational studies is the possible influence of the Hawthorne Effect, in which subjects' reactions in a testing situation are biased due to the attention they receive from the observer. In the present study, subjects were unaware that they were being observed due to the automation of the checklist. Also, since observations were recorded by the computer as subjects interacted with the software, observer bias was greatly reduced. The computer was not affected by fatigue or distractions during the recording of observational data, as is sometimes the case with human observers. Though computerized observations will not be appropriate for every type of study, certainly the use of this tool could ease the collection of some types of data.

The findings of this study indicate that cognitive tempo may influence the number of errors children make when using a computer program, but that these errors do not necessarily affect how often or for how long a period of time children use the computer. It also appears that the computer may be a valuable tool for use in observational research.

Based on these findings, the following recommendations are made for further study:

1. Conduct a similar study using a larger population and random sampling techniques. This would allow statistical analysis to be applied to the resulting data in order to determine the degree of correlation between cognitive tempo and computer use.
2. Modify the software to include collection of latency data. Such modification would be necessary in order to accurately compare cognitive tempo as measured by the KRISP and the observational checklist.
3. Conduct a similar study using more than one computer per classroom so that children have greater opportunity to use the computer.
4. Conduct a similar study comparing reflective and impulsive subjects' use of more structured software which provides both positive and negative feedback.
5. Apply basic principles of programming used in this study to other testing situations.

TABLE 1

DESCRIPTION OF SUBJECTS ACCORDING TO KRISP, PPVT-R, AND COMPUTER SURVEY

Subject	Sex	Age	Krisp Class.	PPVT-R Age Equiv.	Previous Computer Experience
1	M	5-4	Imp.	4-1	none
2	M	5-5	Imp.	4-5	none
6	M	5-1	Imp.	4-3	survey not returned
4	M	5-10	Refl.	6-10	none
9	M	5-5	Refl.	5-6	observed others occasionally; parent uses at work
10	M	4-9	Refl.	ill during testing	observed others often; used 1-10 days/month; computer in home

TABLE 2

FREQUENCIES OF ERRORS IN COMPUTER USE AND KRISP ERRORS
FOR IMPULSIVE AND REFLECTIVE CHILDREN

Subject	KRISP Class	Mean Errors/ Minute	Mean Errors/ 100 Strokes	KRIPS Errors
1	Imp.	0.83	2.94	6
2	Imp.	7.33	11.34	8
6	Imp.	6.03	18.38	11
4	Refl.	0.89	1.87	1
9	Refl.	2.26	4.36	3
10	Refl.	0.67	1.33	1

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